(19) Europäisches Patentamt
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(11) EP 0 830 944 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
25.03.1998 Bulletin 1998/13

(51) Int Cl.[6]: **B41J 2/04**

(21) Application number: **97307268.9**

(22) Date of filing: **18.09.1997**

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **18.09.1996 KR 4065196**

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(54) Ink-jet printing device with drum head

(57) An ink-jet printing device is described using a cylindrical drum-shaped ink cartridge. A plurality of rows of ink-jet heads are formed on the ink cartridge, each including one or more ink ejection orifices, for printing an image onto paper while the ink cartridge rotates. A control unit controls the operation of the ink-jet heads. The rows of heads are either aligned parallel to the axis of the ink cartridge or helically arranged on the surface of the ink cartridge.

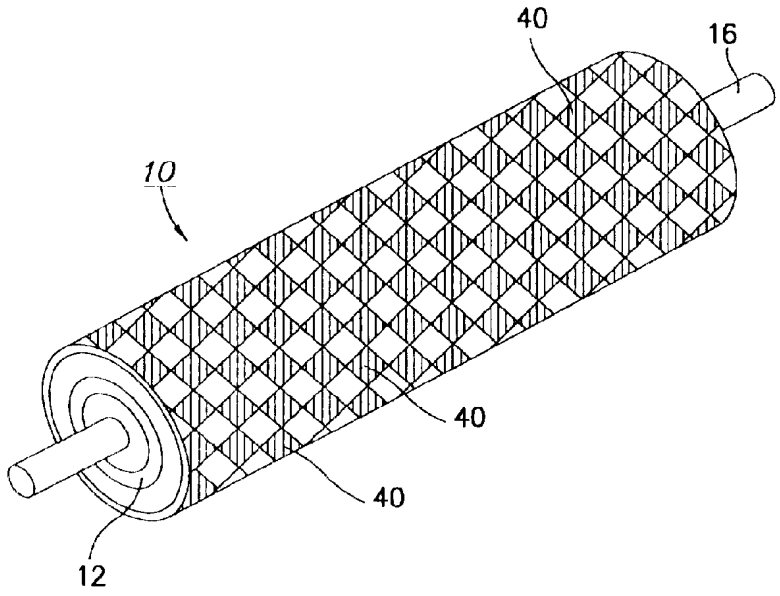

FIG. 5

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Description

Background of the Invention

This invention is applicable to printers, copy machines and plain paper facsimiles. Specifically, this invention relates to an ink-jet printing device.

FIG. 1 is a schematic view illustrating the configuration of a conventional ink-jet printer. The printer has a cassette 72 containing paper 70. Paper feed roller 74, for feeding paper 70 from the paper cassette 72, is installed above the leading edge of cassette 72. A sensor 76, for determining the paper feed state, is installed at one side of paper feed roller 74 to stop paper feed roller 74 and start transfer roller 78. A transfer roller 78 is installed beside sensor 76, and is used to transfer the paper 70 to a cartridge 50 containing a printing head 54. A rectangular shaped cartridge 50, which undergoes a rectilinear reciprocating motion driven by a drive motor, is installed beside transfer roller 78. A platen roller 80 is installed below cartridge 50 and transfers paper 70 while printing using heat. A paper discharge roller 82 is installed near the platen roller 80 to discharge the printed paper to stacker 84.

As shown in FIG. 2, cartridge 50 consists of ink container 51, for storing ink 38, and head 54, for printing images on paper 70 according to electric signals from a control unit. As shown in FIG. 3, illustrating the configuration of head 54, an ejection orifice 56, for ejecting ink 38, is formed in a plate 52, and a channel 58 connects with the ejection orifice 56 to provide ink 38 to the orifice. A heating element 62 is installed in the bottom of the channel 58 and heats and evaporates ink 38 to create vapour pressure. Electrodes 64 are installed on both sides of the heating element 62 to which they supply energy. A substrate layer 68, made of silicon and a resistor layer 66 for insulating the electrodes 64 are installed below the electrodes 64. A protective film 60 is formed on the electrodes 64 to protect the electrodes 64, the heating element 62 and the resistor layer 66 from corrosion and oxidation reactions with the ink.

The operation of the ink-jet printer containing such a head and cartridge and following a rectilinear reciprocating motion during printing, is as follows. Once the printer is switched "on" responding to an initial signal, paper 70 in cassette 72 is transferred by paper feed roller 74 and activates sensor 76. Paper feed roller 74 stops after a specified period of time based on the distance to transfer roller 78. The paper is fed to cartridge 50 by transfer roller 78. Cartridge 50 prints while transferring the paper at a speed calculated from a step which is the distance between the paper and transfer roller 78.

As shown in FIG. 3, once the control unit sends a print command to head 54, voltage is applied to electrodes 64. Heating element 62 is heated by electrodes 64, so that ink in close proximity is evaporated, and a bubble is created. Ink in channel 58 is sprayed onto the paper through ejection orifice 56 by vapour pressure, thus forming the desired letters or pictures. Platen roller 80 fixes the image to the paper using a high voltage between 500 and 5000V. The paper is then transferred to stacker 84 by paper discharge roller 82, ending the printing process.

With conventional ink-jet printers, head 54 is installed in a serial matrix configuration and prints while following a rectilinear reciprocating motion. The operation of such a head requires high technology to control the reciprocating motor to maintain resolutions exceeding 300 dots per inch (dpi) and precise transference of head 54 as well as a mechanism for the rectilinear reciprocating motion of head 54. Serial heads following a rectilinear reciprocating motion are limited in printing speed. Special mechanisms must be installed to increase printing speed, but this makes the products very large and bulky.

Summary of the Invention

An objective of the present invention is to create an ink-jet printing device which is capable of producing resolution exceeding 300dpi as the head rotates.

Another objective of the present invention is to provide an ink-jet printing device of increased printing speed.

Accordingly, the present invention provides an ink-jet printing device comprising:

a cylindrical drum-shaped ink cartridge;
a plurality of rows of ink-jet heads formed on the ink cartridge, each including one or more ink ejection orifices, for printing an image onto paper while the ink cartridge rotates; and
a control unit for controlling the operation of the ink-jet heads.

The ink-jet printing device preferably further comprises a paper feed roller for feeding paper from a paper cassette; a sensor for detecting paper fed by the feed roller; a transfer roller for feeding the paper into a paper feed path upon detection by the sensor; and a paper discharge roller for transferring the printed paper to a stacker.

The ink-jet printing device may further comprise a platen roller for fixing the image onto the paper and provided on the opposite side of the feed path from the ink cartridge.

The rows of heads may be aligned parallel to the axis of the ink cartridge, but re preferably helically arranged on the surface of the ink cartridge. The said rows of heads are alternately arranged on the ink cartridge, forming a chequer-board pattern.

Each head may comprises a heater chip for heating the ink and a nozzle plate for ejecting the ink onto the paper. In particular, it may comprise:

a resistor portion for heating the ink and creating

vapour pressure, including first and second electrodes for providing the resistor portion with an applied voltage;
a slot for transferring the ink from an ink chamber in the ink cartridge to the resistor portion; and
a channel for transferring ink from the resistor portion to the ejection orifices.

Two or more ejection orifices may be formed in each nozzle plate.

Brief Description of the Drawings

The present invention will now be described by way of example with reference to the accompanying drawings, in which:

FIG. 1 is a schematic illustration of a conventional ink-jet printer;
FIG. 2 is a side view of a cartridge in a conventional ink-jet printer;
FIG. 3 is a cross sectional view of the head of a conventional ink-jet printer;
FIG. 4 is a schematic illustration of an ink-jet printer according to the present invention;
FIG. 5 is a perspective view of a drum cartridge in an ink-jet printer according to the present invention;
FIG. 6 is a cross sectional view of the head of a drum cartridge in an ink-jet printer according to the present invention; and
FIG. 7 is a detail of part "A" in FIG. 6.

Detailed Description of the Preferred Embodiment

As shown in FIG. 4, the printer has a cassette 72 containing paper 70. A paper feed roller 74 for feeding the paper in cassette 72 is installed above the leading edge of cassette 72. A sensor 76 for sensing the paper feed state is installed beside the paper feed roller 74 to determine when to stop the paper feed roller 74 and start the transfer roller 78. The transfer roller 78 is installed beside sensor 76 to transfer the paper 70 to a drum cartridge 10 with head 54. The cylindrical drum cartridge 10, which rotates on shaft 16, is installed beside the transfer roller 78. Platen roller 80 is installed under the drum cartridge 10 to fix an image to the paper with a high voltage while transferring the paper. Paper discharge roller 82 is installed beside platen roller 80 to transfer the printed paper to stacker 84.

As shown in FIG. 5, the surface of the drum cartridge 10 has heads 40 which print images on the paper based upon electric signals from the control unit while the cartridge rotates on shaft 16. One or more lines of heads 40 are arranged forming a spiral helix about the shaft with a specified angle creating a chequer-board pattern. Of course, the lines of heads could be parallel to the axis of the cartridge, and in that case skewing of the image could be reduced by using a line buffer to store the data for a line of printing and sending the data to the heads simultaneously. Head 40 consists of heater chip 18, for heating ink 38, and nozzle plate 14, for ejecting ink 38 to the paper.

As shown in FIGS. 6 and 7, the head 40 includes a nozzle plate 14 with ejection orifices 30 for ejecting the bubble 34 of ink 38 onto the paper as a form of a drop 32 and a channel 36 which is connected to ejection orifices 30 to introduce ink 38 in form of bubble 34. Two or more ejection orifices 30 are formed in the nozzle plate 10 to increase the print speed.

Resistor portions 24 are installed at one side of channel 36 to create vapour pressure and bubbles 34 by heating ink 38. First and second electrodes 22 and 23 are installed on both sides of each resistor portion 24 to heat the resistor portion 24 by applying a specified voltage. Slot 28, between resistor portions 24, draws ink 38 toward the parts of the channel 36 where resistor units 24 are installed. The first and second electrodes, 22 and 26, and resistor portions 24 are installed on substrate layer 12, which is made of silicon. The chamber 20 is created inside substrate layer 12.

The operation of the ink-jet printer with the drum type head having such structure is as follows. As shown in FIG. 4, once the printer is switched "on" responding to an initial signal, paper 70 in cassette 72 is transferred by paper feed roller 74 and activates sensor 76. Paper feed roller 74 stops after a specified period of time based on the distance from transfer roller 78. The paper is transferred to drum cartridge 10 by transfer roller 78. Drum cartridge 10 starts printing on the paper while rotating in the specified direction. As shown in FIG. 7, once the control unit sends a print command to head 40, first and second electrodes 22 and 26 are provided with voltage and heat resistor portions 24. At the same time, ink 38 stored in chamber 20 flows into channel 36 through slot 28. Ink 38, near resistor portions 24 is evaporated and forms bubbles 34. Bubbles 34 of ink 38 are ejected onto the paper in the form of dots 32 through ejection orifices 30 connected to channel 36, thus forming letters or pictures.

The platen roller 80 in FIG. 4 fixes the image to the paper with a high voltage between 500 and 5000V. The printed paper is transferred to stacker 84 by paper discharge roller 82, and the printing process ends.

As described above, the ink-jet printer with the drum type head according to the present invention can produce resolution exceeding 300dpi because the head is installed in a rotating drum cartridge instead of a cartridge following a rectilinear reciprocating motion. The present invention also increases the print speed to between 5ppM and 20ppM by forming two or more ejection orifices in the head of the drum cartridge. Since the drum cartridge does not require a moving carriage to allow for rectilinear motion, the product can be miniaturized.

Claims

1. An ink-jet printing device comprising:

   a cylindrical drum-shaped ink cartridge;
   a plurality of rows of ink-jet heads formed on the ink cartridge, each including one or more ink ejection orifices, for printing an image onto paper while the ink cartridge rotates; and
   a control unit for controlling the operation of the ink-jet heads.

2. An ink-jet printing device according to claim 1 further comprising a paper feed roller for feeding paper from a paper cassette.

3. An ink-jet printing device according to claim 2 further comprising a sensor for detecting paper fed by the feed roller and a transfer roller for feeding the paper into a paper feed path upon detection by the sensor.

4. An ink-jet printing device according to claim 3 further comprising a platen roller for fixing the image onto the paper and provided on the opposite side of the feed path from the ink cartridge.

5. An ink-jet printing device according to any preceding claim further comprising a paper discharge roller for transferring the printed paper to a stacker.

6. An ink-jet printing device according to any preceding claim in which the said rows of heads are aligned parallel to the axis of the ink cartridge.

7. An ink-jet printing device according to any one of claims 1-5 in which the said rows of heads are helically arranged on the surface of the ink cartridge.

8. An ink-jet printing device according to any preceding claim in which the said rows of heads are alternately arranged on the ink cartridge, forming a chequer-board pattern.

9. An ink-jet printing device according to any preceding claim in which each head comprises a heater chip for heating the ink and a nozzle plate for ejecting the ink onto the paper.

10. An ink-jet printing device according to claim 9 in which each head comprises:

    a resistor portion for heating the ink and creating vapour pressure, including first and second electrodes for providing the resistor portion with an applied voltage;
    a slot for transferring the ink from an ink chamber in the ink cartridge to the resistor portion; and
    a channel for transferring ink from the resistor portion to the ejection orifices.

11. An ink-jet printing device according to claim 9 or claim 10 in which two or more ejection orifices are formed in each nozzle plate.

12. An ink-jet printing device as described with reference to and as illustrated in FIGs. 4 et seq. of the accompanying drawings.

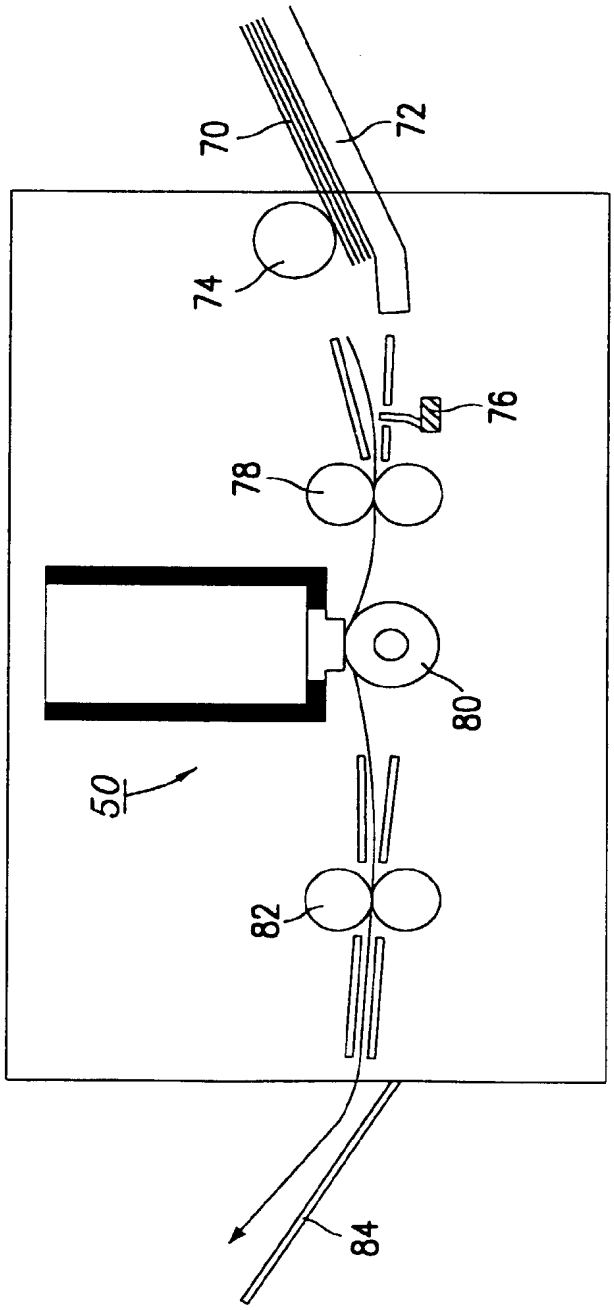

FIG. 1

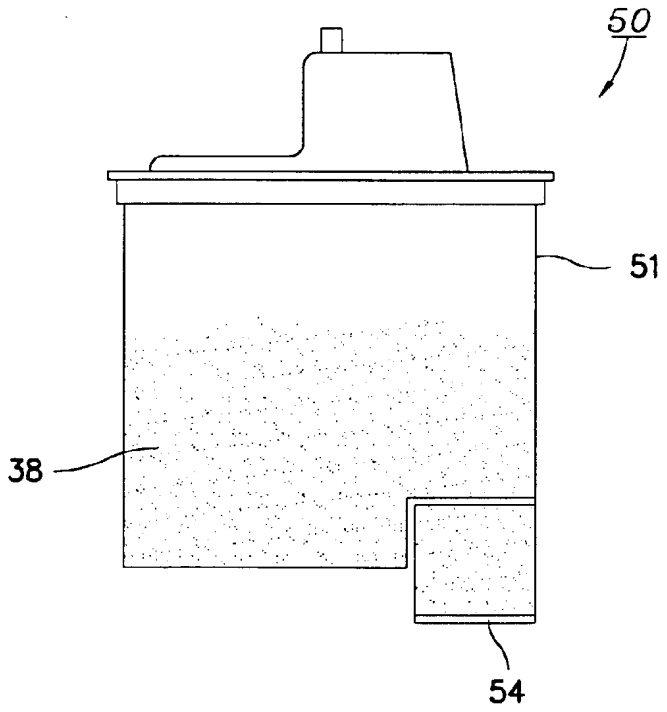

FIG. 2

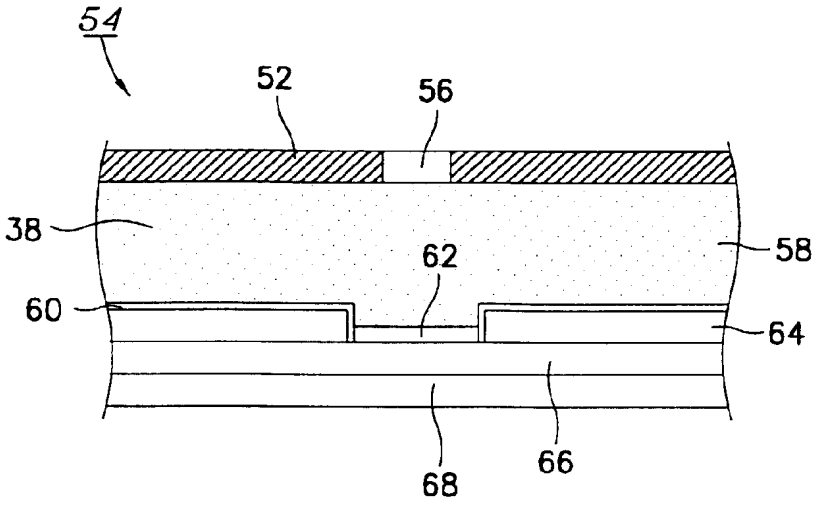

FIG. 3

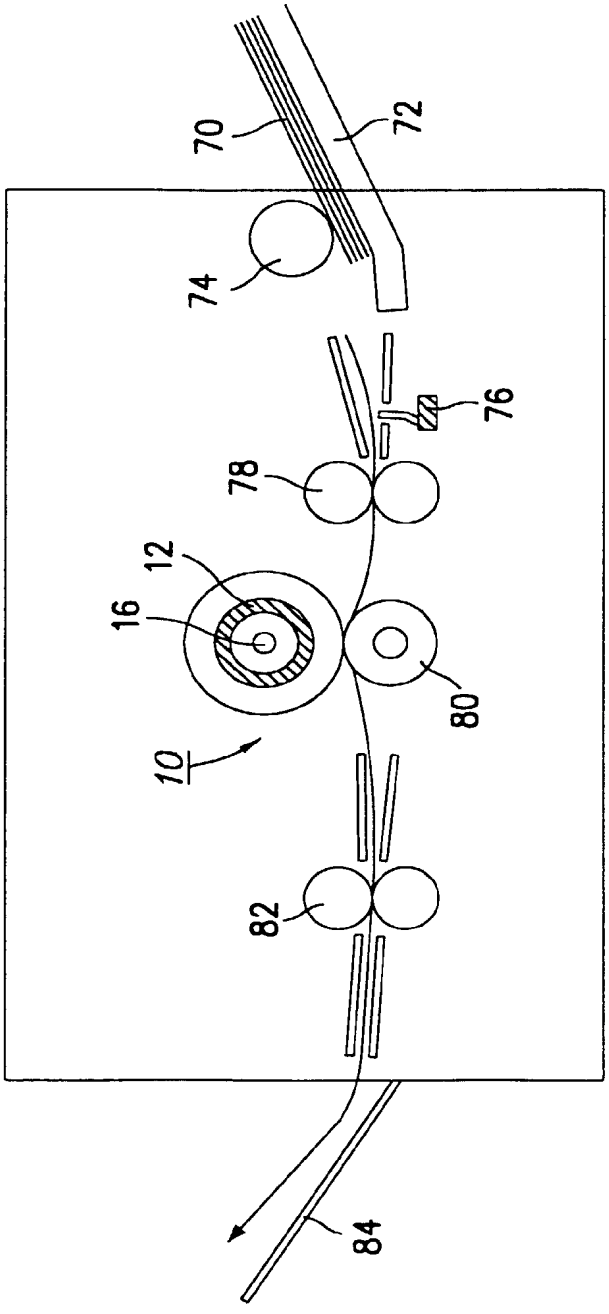

FIG. 4

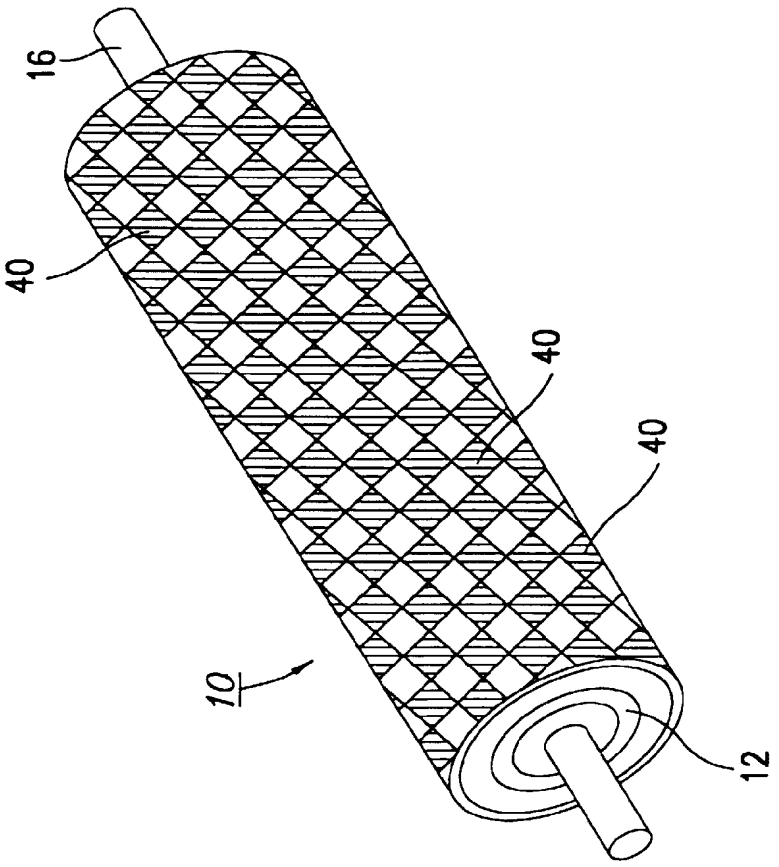

FIG. 5

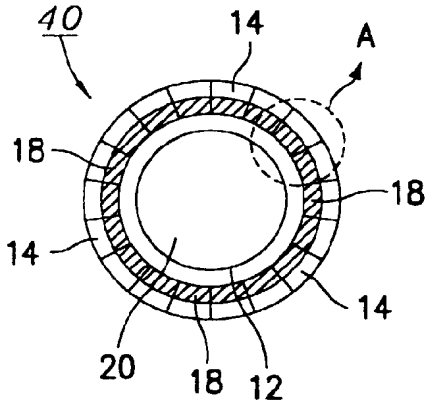
40
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FIG. 6

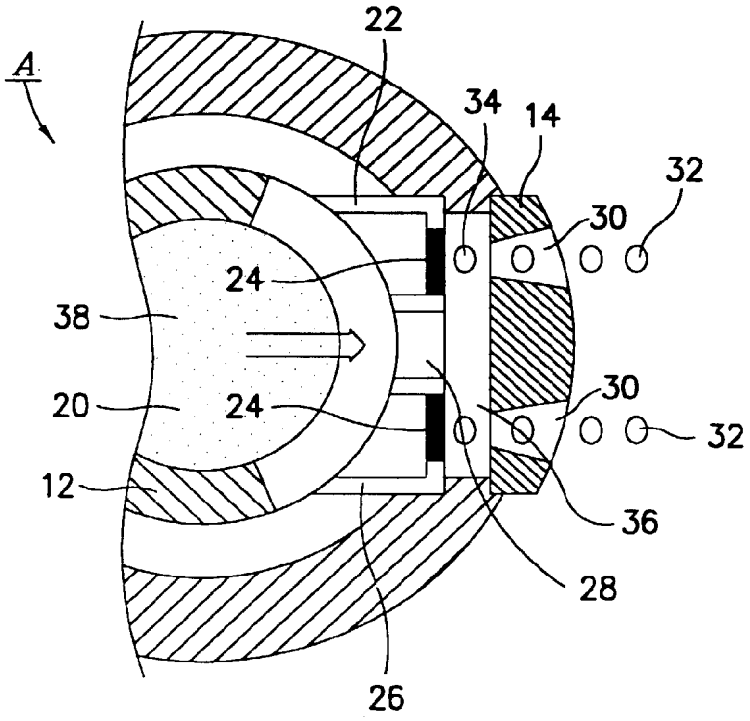
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FIG. 7

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(11) EP 0 830 944 A3

(12) EUROPEAN PATENT APPLICATION

(88) Date of publication A3:
03.03.1999 Bulletin 1999/09

(43) Date of publication A2:
25.03.1998 Bulletin 1998/13

(21) Application number: **97307268.9**

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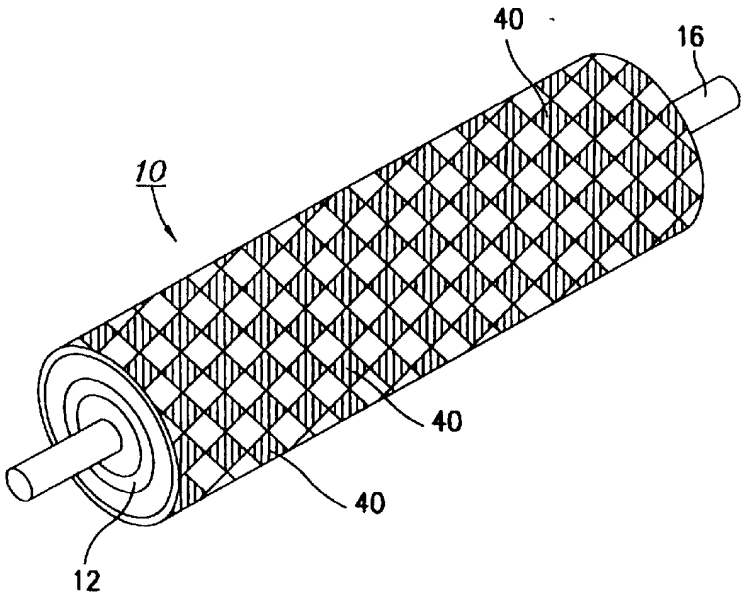

FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 97 30 7268

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	5 January 1999	Didenot, B

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EUROPEAN SEARCH REPORT

Application Number
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The present search report has been drawn up for all claims

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